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Two New Non-commensal Loxosomatids (Entoprocta: Loxosomatidae) from Okinawa and Sesoko Islands, Ryukyu Archipelago, Japan

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Two new loxosomatids, *Loxomitra ryukyuensis* sp. nov. and *Loxosomella parvipes* sp. nov., are described from Okinawa Island and Sesoko Island, respectively, in the Ryukyu Archipelago, Japan. Both species were found on glass slides that had been immersed, respectively, in a fishery port or an aquarium at a marine station, which indicates that both are non-commensal species. Some individuals of *L. ryukyuensis* found in August were brooding embryos and larvae. Larval morphology is described for the first time in the genus *Loxomitra*.

Key Words: Entoprocta, Kamptozoa, *Loxosomella*, *Loxomitra*, new species, coral reef, larva.

Introduction

Loxosomatidae is a family that encompasses all solitary species in the phylum Entoprocta (=Kamptozoa). Approximately 140 species have been described so far in this family, most of which are known to associate with larger benthic animals such as polychaetes, sponges, bryozoans, and sipunculans (Nielsen 1964). The host animals are believed to provide loxosomatids with safe habitats (Iseto 2005) and water currents that bring suspended food particles and fresh water (Nielsen 1964). Only a few species have been found not associated with other animals (Iseto 2005).

The Ryukyu Archipelago is a subtropical area in southern Japan. The loxosomatid fauna in this area has not been adequately surveyed and only ten species (six *Loxosomella*, two *Loxomitra*, two *Loxocorone*) have been described from there to date (Iseto 2001, 2002, 2003). The ten species are all non-commensal, having been found always on non-living substrata, such as stones, dead coral fragments, and shell remains collected from the sea, as well as on glass slides that had been placed in the sea. Surveys in the Ryukyu Archipelago using settlement panels (glass slides) are unveiling the large fauna of non-commensal loxosomatids that have long been regarded as exceptional. This report describes two new non-commensal species found by extensive surveys using glass slides in the Okinawa Islands of the Ryukyu Archipelago.

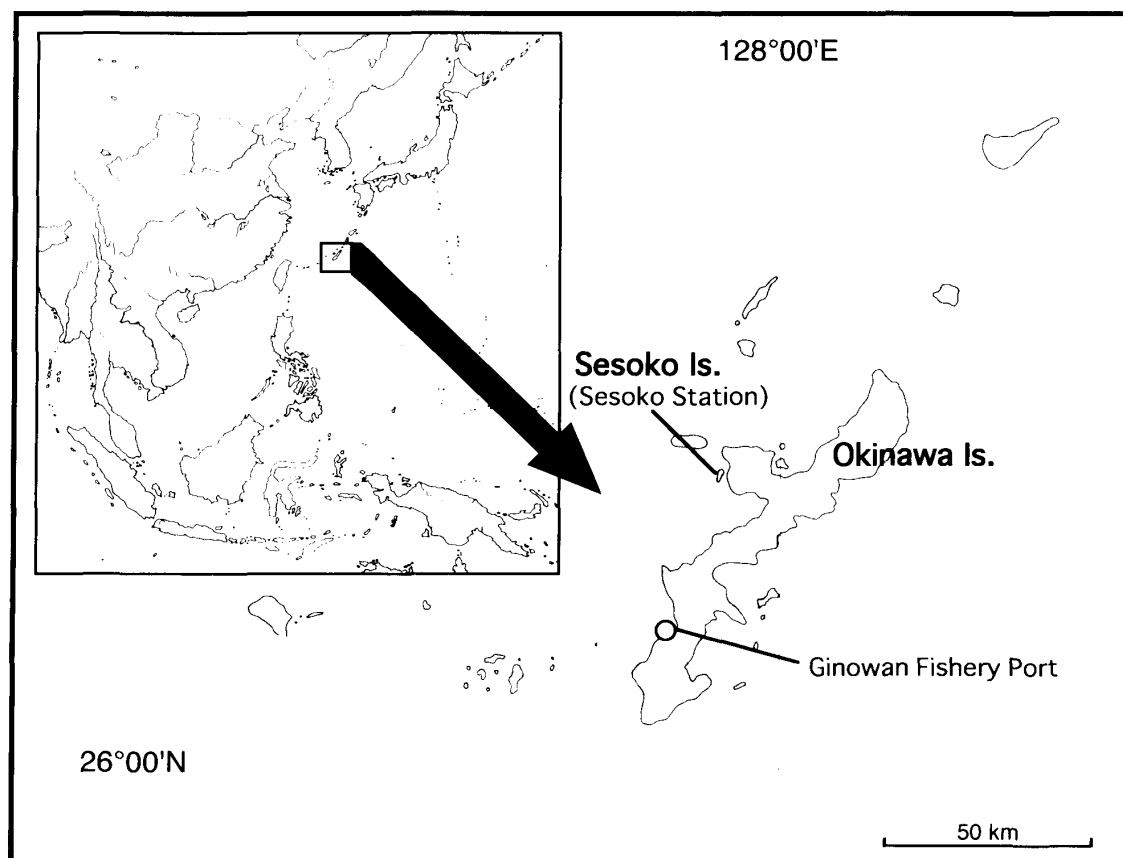


Fig. 1. Map of Okinawa Island, Sesoko Island, and vicinity, showing the locations of the type localities of the species described in this study: Ginowan Fishery Port and the Sesoko Station of the Tropical Biosphere Research Center, University of the Ryukyus.

Materials and Methods

Sampling of solitary entoprocts was carried out at Ginowan Fishery Port (26°17'N, 127°45'E) on the west coast of Okinawa Island and at the Sesoko Station of the Tropical Biosphere Research Center, University of the Ryukyus (26°38'N, 127°52'E) on Sesoko Island, just off northwestern Okinawa Island (Fig. 1). In Ginowan Fishery Port, glass slides were suspended from a pier at a depth of about 4 m and collected after two months. At the Sesoko Station, glass slides were placed on the bottom of a 1 m deep aquarium and collected after four months. The aquarium was continuously supplied with seawater pumped from a point 5 m deep and 150 m off the coast in front of the station. Solitary entoprocts found on these slides were removed and narcotized by adding 0.37 M MgCl_2 to the seawater, and then fixed with 2% formalin in seawater (Iseto 2001). All the drawings were prepared on the basis of fixed specimens under a light microscope equipped with a camera lucida. Type specimens have been stored in 2% formalin in seawater and deposited in the National Science Museum, Tokyo (NSMT).

Taxonomy

Genus *Loxomitra* Nielsen, 1964
Loxomitra ryukyuensis sp. nov.
(Figs 2–4)

Material examined. Holotype: an adult (NSMT-Ka 74) found on 13 Dec. 2000 on a glass slide that had been suspended for two months at a depth of about 4 m at the Ginowan Fishery Port (26°17'N, 127°45'E), Okinawa Island, the Ryukyu Archipelago, Japan. Paratypes: three adults (NSMT-Ka 75, 76, 77) collected with the holotype; 25 adults (NSMT-Ka 78) collected with the holotype; two adults (NSMT-Ka 79) found on 16 Aug. 2000 on a glass slide that had been suspended at the type locality for two months; 15 adults (NSMT-Ka 80) with developing embryos in their calyx, found on 15 Aug. 2001 on a glass slide that had been suspended at the type locality for two months; 12 adults (NSMT-Ka 81) without embryos collected with NSMT-Ka 80; a liberated bud (NSMT-Ka 82) derived from an adult collected with NSMT-Ka 79.

Etymology. The specific name refers to the type locality.

Description. *Adult.* Total length (from basal end of stalk to uppermost part of tentacular membrane) 589–2326 μm . Calyx length (from basal end of stomach to uppermost part of tentacular membrane) 196–584 μm . Tentacle number 12–20. Stalk (from basal attachment to basal end of stomach) 1.9–4.1 times longer than calyx. Adult without foot and cemented to substratum by stalk base. Pair of lateral sense organs present at level slightly above upper side of stomach (Fig. 2A, B), each with only one or a few sensory hairs (Fig. 3E). No conspicuous appendages anywhere on body. Stomach rounded-triangular with basal corner rather pointed. Lateral lobe of stomach absent. Calyx not covered by detritus. Basal part of stalk often covered by detritus.

Liberated bud. Only one individual (NSMT-Ka 82) was examined (Figs 2I–K, 3F, G). Total length (from basal tip of foot to uppermost part of tentacular membrane) 639 μm . Tentacle number 14. Foot with pair of terminal wings and several gland cells (Fig. 3G). Foot groove absent. Pair of lateral sense organs present (Fig. 2I, J).

Larva. Larva body (Fig. 3I, J) conical with basal ring of cilia (prototroch). Apical organ with ciliary bundle present. Frontal organ not detected. Eyes absent. Body not covered by detritus. No stalked vesicles on episphere.

Reproduction. Buds emerge from the frontal area of the calyx at the level of the middle of the stomach, attaching themselves to their parent's calyx by the back of the median part of the stalk. A maximum of four buds was observed simultaneously on a single parent, among which only one bud enlarges at a time. Adults brooding embryos (Fig. 3H) and a swimming larva (Fig. 3I, J) were found in August, 2001. One to seven embryos were observed in a single parent.

Discussion. The tiny foot with a pair of terminal wings and the characteristic budding mode, whereby the buds are attached to the parent by the stalk, indicate that this species belongs to the genus *Loxomitra* (see Iseto 2002). Among the five species so far described for this genus, the present species resembles *Loxomitra kefersteinii* (Claparède, 1867) in general appearance; however, the two species can be distinguished from each other by several characteristics. The total length of the present species in the adult stage (over 2.3 mm) is considerably larger than that of *L. kefersteinii* (up to 1.6 mm; see Ryland and Austin 1960). The calyx length of *L.*

kefersteinii was reportedly up to 330 μm in specimens from Swansea (Ryland and Austin 1960) and about 360 μm in a large individual from Florida (calculated from Nielsen 1966b, fig. 11A). In the present species, calyx length attains 584 μm in the largest specimen, which is considerably larger than that in *L. kefersteinii*. A difference in body size is also conspicuous in the bud stage. Whereas the size of a newly liberated bud of the present species (NSMT-Ka 82) is 639 μm , the buds of even the largest *L. kefersteinii* are only 440 μm long (Nielsen 1966b).

Body size is known to be highly variable in the Loxosomatidae and it may not be decisive in distinguishing between these two species. The tentacle number, although also highly variable in this species, proved to be a key character for distinguishing *L. ryukyuensis* from *L. kefersteinii*. In the present species, increase in tentacle number depends on body size and reaches 20 when the calyx length is about 500 μm ; tentacle number does not increase further in larger individuals (Fig. 4). In contrast, *L. kefersteinii* attains 14 tentacles when the calyx length reaches about 250 μm (cf. Ryland and Austin 1960, fig. 1a, b), and even larger individuals never have more tentacles. As such, each species has its own limit of tentacle number and specific body size at which the largest number is attained. This characteristic separates the two species, although middle-sized individuals of the present species, which sometime have 14 tentacles, may look similar to large individuals of *L. kefersteinii*.

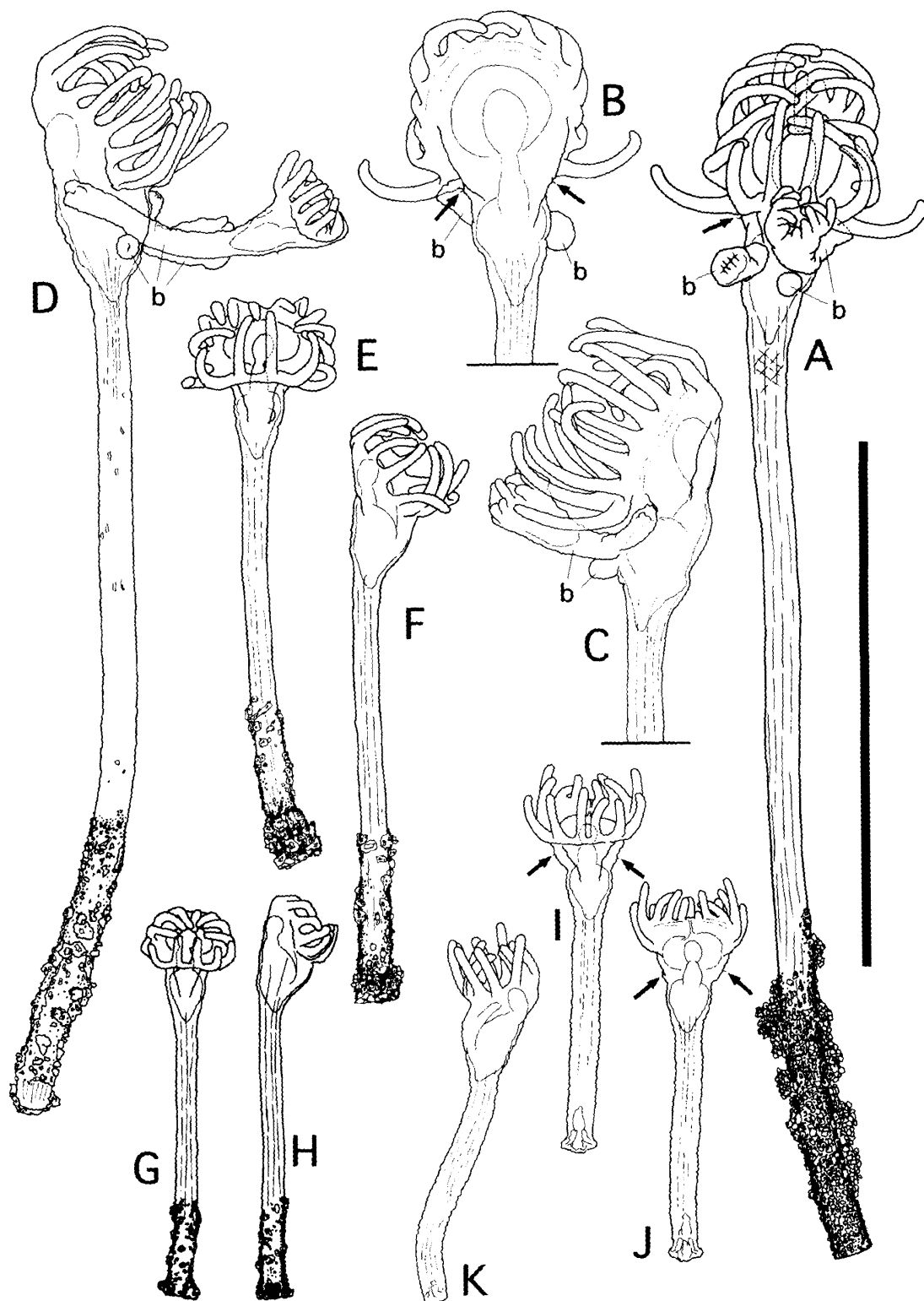
The stomachs of both species are rounded-triangular and lack lateral lobes; however, the basal end of the stomach is more angular in the present species than in *L. kefersteinii* (cf. Nielsen 1989, fig. 22). This characteristic seems invariable among the specimens of each species.

The present species has a pair of lateral sense organs both in the liberated bud and the adult, but the organ has not been described in *L. kefersteinii*. This difference may also allow discrimination of the two species, but the sense organs of the present species, which may have only a single sensory hair, were difficult to detect by light microscopy (Fig. 3E). It is thus possible that *L. kefersteinii* also has rudimentary lateral sense organs, which were overlooked in past studies.

Loxomitra mizugamaensis Iseto, 2002 and *Loxomitra tetraorganon* Iseto, 2002 also resemble the present species in their slender body outline, but these two species invariably have only nine tentacles from the bud through the adult stage (Iseto 2002).

Only a single larva (Fig. 3I, J) was obtained, and the specimen was lost after observation. It lacked pigmented eyes and stalked vesicles, and probably lacked a frontal organ. It thus differed from the larvae of most species of *Loxosomella*, which have a frontal organ and eyes. However, larvae of some other species of this

Fig. 2. *Loxomitra ryukyuensis* sp. nov. A–C, Holotype (NSMT-Ka 74) with three buds (b) of different sizes, frontal view of whole body (A) and abfrontal and left side views of calyx (B, C); D, right side view of paratype (NSMT-Ka 75) with three buds (b); E, F, frontal and right side views, respectively, of middle-sized adult (paratype: NSMT-Ka 76); G, H, frontal and right side views, respectively, of the smallest adult collected (paratype: NSMT-Ka 77); I–K, frontal, abfrontal, and left side views, respectively, of liberated bud (paratype: NSMT-Ka 82). Arrows in A, B, I, J indicate lateral sense organs; these organs are probably present in pairs in all individuals, but are not always indicated in the drawings because in some orientations they cannot be detected owing to their small size. Scale=1 mm.



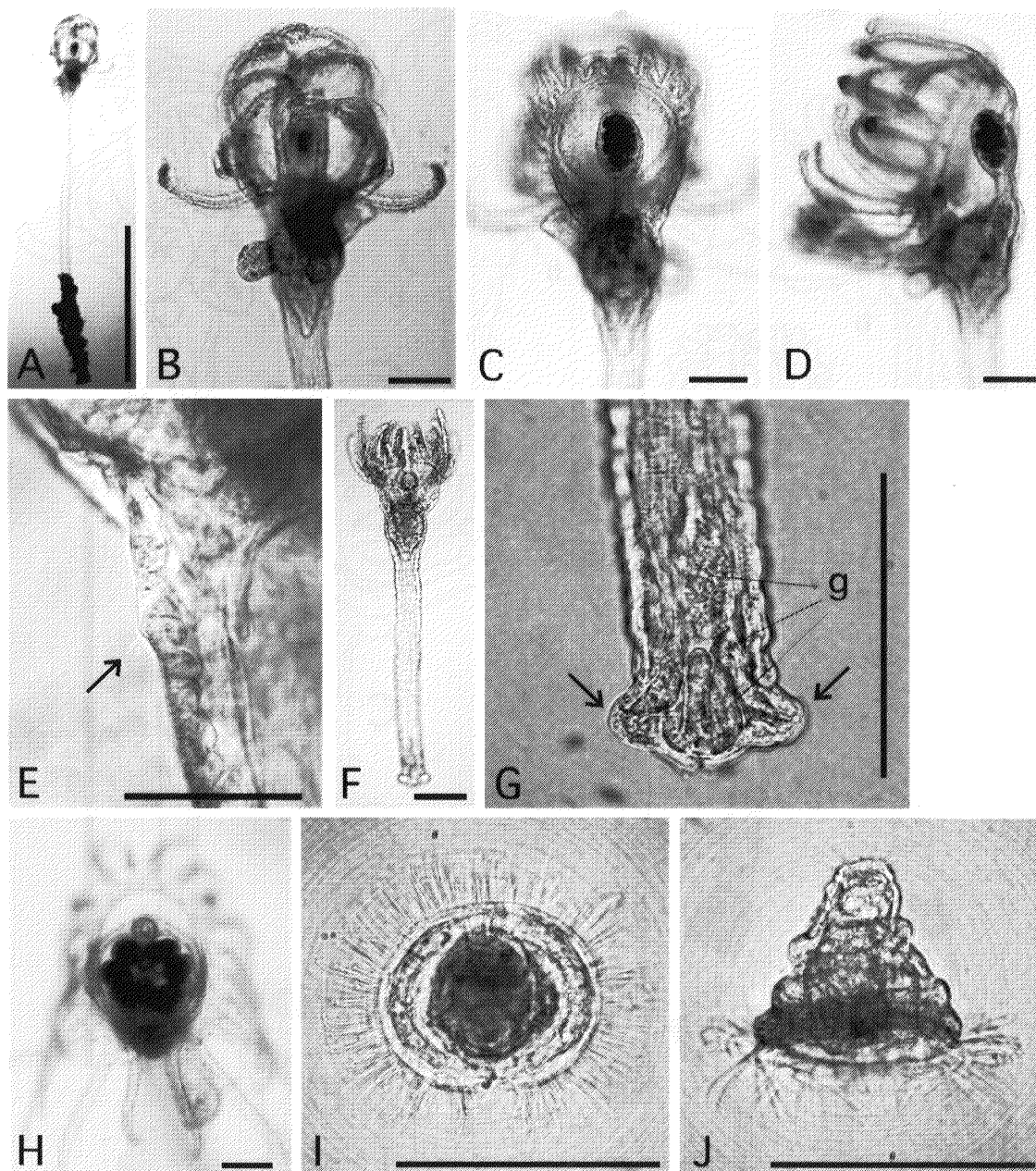


Fig. 3. Photographs of *Loxomitra ryukyuensis* sp. nov. A–E, Holotype (NSMT-Ka 74), frontal view of whole body (A), frontal, abfrontal, and left side views, respectively, of calyx (B–D), and lateral sense organ with single sensory hair (arrow) (E); F, G, whole body and foot part of liberated bud, respectively (paratype: NSMT-Ka 82), g indicates foot gland, arrows indicate terminal wings; H, adult brooding embryos; I, J, larva in top and lateral views, respectively. Scales=1 mm in A; 100 μ m in B–D, F–J; 50 μ m in E.

genus (e.g., *Loxosomella atkinsae* Bobin and Prenant, 1953 and *L. elegans* Nielsen, 1964) lack the frontal organ and eyes (Nielsen 1971) and, in this point, they resemble the present larva. Some larvae of *Loxosoma* lack the two organs (Nielsen 1971) but all *Loxosoma* larvae described so far have stalked vesicles on the episphere (Nielsen 1996), which were not observed in the present species. This is the first re-

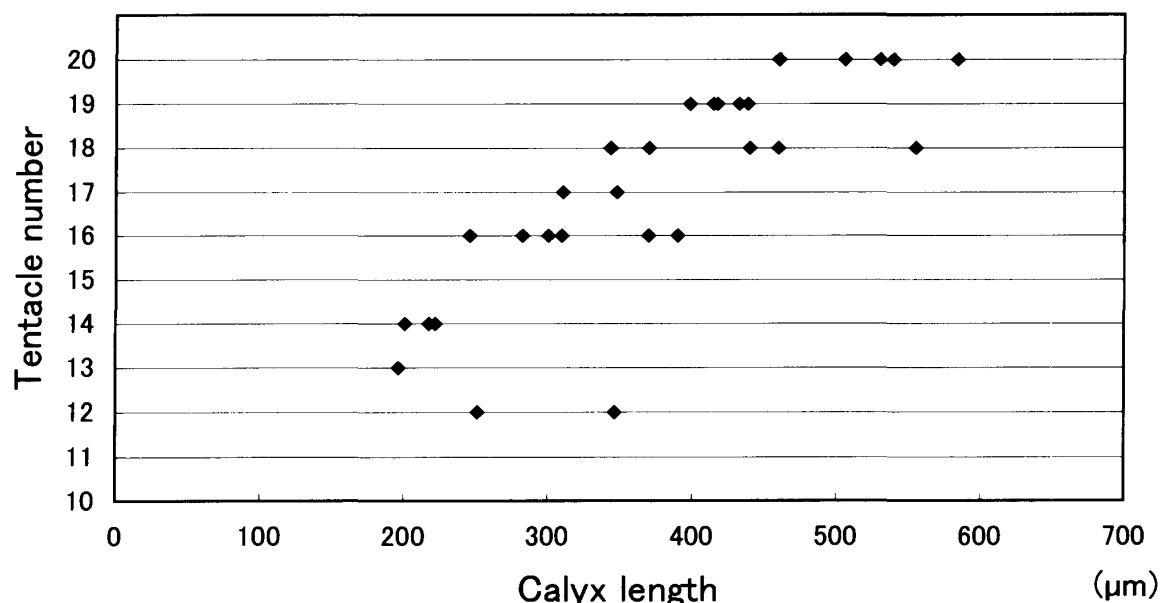


Fig. 4. Relationship between calyx length and tentacle number in *Loxomitra ryukyuensis* sp. nov. collected from Ginowan Fishery Port.

port of a larva of the genus *Loxomitra*. Observations on the larvae of other species of *Loxomitra* are necessary to specify the general larval morphology of this genus and discuss its relationships to other genera based on larval morphology.

Genus *Loxosomella* Mortensen, 1911

Loxosomella parvipes sp. nov.

(Figs 5–6)

Material examined. Holotype: an adult (NSMT-Ka 83) found on 11 Nov. 2004 on a glass slide that had been placed for four months at a depth of about 1 m in an aquarium at the Sesoko Station of the Tropical Biosphere Research Center, University of the Ryukyus (26°38'N, 127°52'E), Sesoko Island, just off northwestern Okinawa Island. Paratypes: two adults (NSMT-Ka 84, 85) collected with the holotype; 25 adults (NSMT-Ka 86) collected with the holotype.

Etymology. The specific name is composed of two Latin words, *parvus* meaning small and *pes* meaning foot, in reference to the small foot that does not increase in size even in large individuals.

Description. Total length (from basal attachment of foot to uppermost part of tentacular membrane) 369–1051 μm. Tentacle number 12–18. Stalk 1.0–2.1 times longer than calyx. Foot with foot gland and foot groove lined with accessory cells both in adult (Fig. 6F) and bud (Fig. 6G). Foot gland small and bean-shaped, not longer than 40 μm. Pair of lateral sense organs present on lateral side of calyx at level of upper side of stomach (arrows in Fig. 5A, B, E), each with only a few sensory hairs (arrow in Fig. 6E). No conspicuous appendages anywhere on body. Entire body free of covering detritus. Newly liberated bud (Figs 5F, 6I, J) resembling parent but smaller in calyx size, stalk length, and tentacle number. Foot size simi-

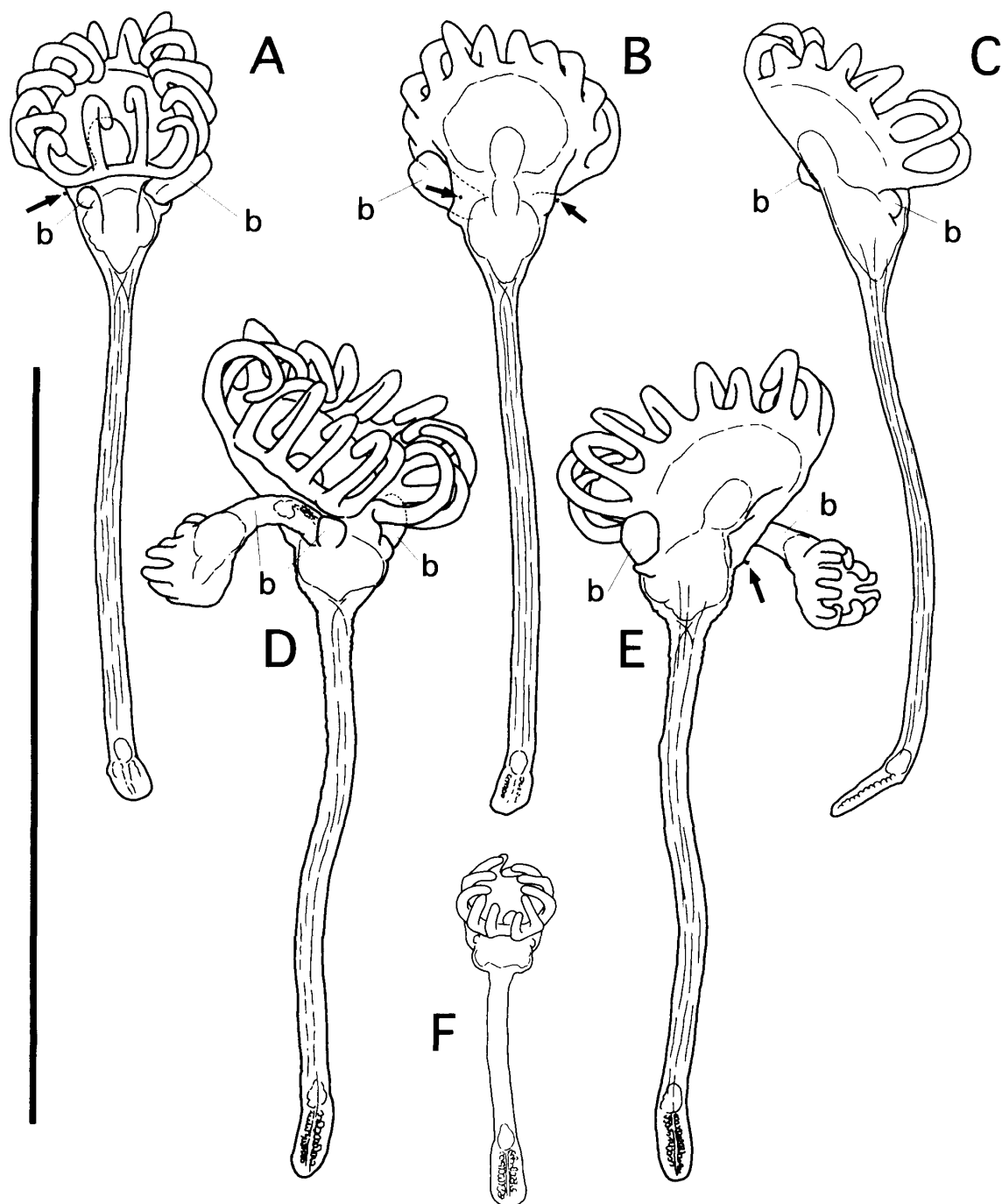


Fig. 5. *Loxosomella parvipes* sp. nov. A–C, Holotype (NSMT-Ka 83) with two buds (b) in frontal, abfrontal, and right side views, respectively; D, E, paratype (NSMT-Ka 84) with three buds (b) in oblique frontal and oblique abfrontal views, respectively; F, small adult (paratype: NSMT-Ka 85) in frontal view. Arrows in A, B, and E indicate lateral sense organs; these organs are probably present in pairs in all individuals, but are not always indicated in the drawings because in some orientations they cannot be observed owing to their small size. In D, E, and F the lower part of the stomach retracted somewhat during fixation, losing its natural shape; the stomach of the holotype (A–C) retains its natural shape. Scale=1 mm.

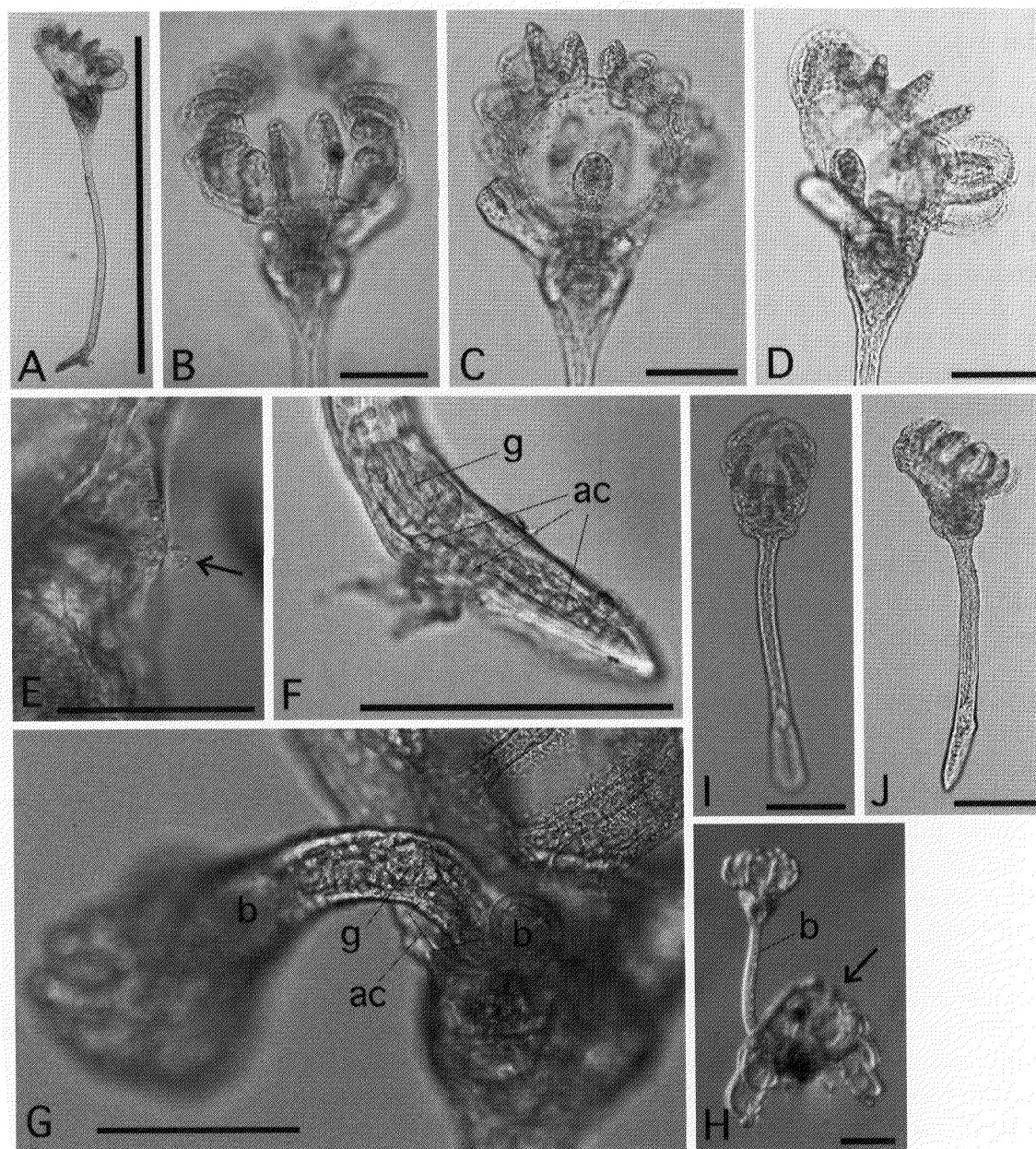


Fig. 6. Photographs of *Loxosomella parvipes* sp. nov. A–F, Holotype (NSMT-Ka 83), right side view of whole body (A), frontal, abfrontal, and right side views, respectively, of calyx (B–D), lateral sense organ with several sensory hairs (arrow) (E), and foot in left side view (F), g indicates foot gland, ac indicates accessory cells along foot groove; G, budding area of paratype (NSMT-Ka 84), showing one large and one small bud (b), the large one being attached to the parent's body by the distal tip of the foot, other abbreviations as in F; H, view in life of different parent calyx (arrow; facing down in the picture) with large bud (b) elongating towards backside of the parent; I, J, frontal and right side views, respectively, of small adult (paratype: NSMT-Ka 85). Scales=1 mm in A; 100 μ m in B–D, F–J; 50 μ m in E.

lar to that of parent, indicating constancy of foot size throughout growth of the animal.

Reproduction. Buds emerge from a pair of small, shallow pockets in the laterofrontal areas of the calyx at the level of the upper end of the stomach, where they are attached by the posterior tip of the foot. A maximum of three buds was observed simultaneously on a single parent, among which only one elongates at a time. Growing buds elongate towards the back of the parent's body, and the calyx of large buds is thus generally seen behind the parent's calyx (Fig. 6H). Sexual reproduction has not been observed.

Discussion. The presence of a foot with a foot groove and accessory cells along the groove indicates that the present species belongs to *Loxosomella* or *Loxocorone*. The budding mode whereby the bud is attached to the parent by the foot tip (not by the stalk) indicates that it belongs to the former genus. Among about 90 species of *Loxosomella* reported so far, the present species resembles *Loxosomella lineata* (Harmer, 1915), *Loxosomella tethyae* (Salensky, 1877), and *Loxosomella vivipara* Nielsen, 1966 in its slender body with a long stalk and a foot that persists in the adult stage. However, *L. lineata* is distinguished from the present species by the presence of lateral thin expansions on the calyx, vesicular cells at the distal margin of the calyx, a pair of lateral pockets of the stomach, four longitudinal lines in the stalk, and well-marked lateral alate expansions of the foot (Harmer 1915). Likewise, *L. tethyae* is distinguishable from the present species by the presence of an irregular row of large cells along the backside of the calyx and a pair of small lateral wings on the foot (Nielsen 1966b). Finally, *L. vivipara* resembles the present species in that the buds grow behind the parent, but differs in the presence of large transparent cells in the calyx, a pair of lateral pockets of the stomach, thin expansions of the lateral margins of the calyx in large individuals, and sensory bristles along the edges of these expansions. Some individuals of *L. vivipara* also have a peculiar circular organ with a central pore, the function of which is unknown, behind the calyx (Nielsen 1966a). This organ is not found in the present species. The largest tentacle number in *L. vivipara* (16) is also different from that of the present species (18).

The present species and also *Loxomitra ryukyuensis* were found on glass slides immersed in an aquarium or a fishery port. This indicates that they are non-commensal species, i.e. they have no association with any host animals. Although the natural habitats of these two species are not known, Iseto (2001, 2002) reported that species first collected from glass slides are also found on non-living objects (e.g., coral rubble, shell remains) in the natural environment. The natural habitats of the present two species may also include such non-living objects.

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